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INSIGHTS OF THE AD 1755 LISBON TSUNAMI IN THE ESTUARY OF THE ALCABRICHEL RIVER (PORTUGUESE WESTERN COAST)

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ABSTRACT

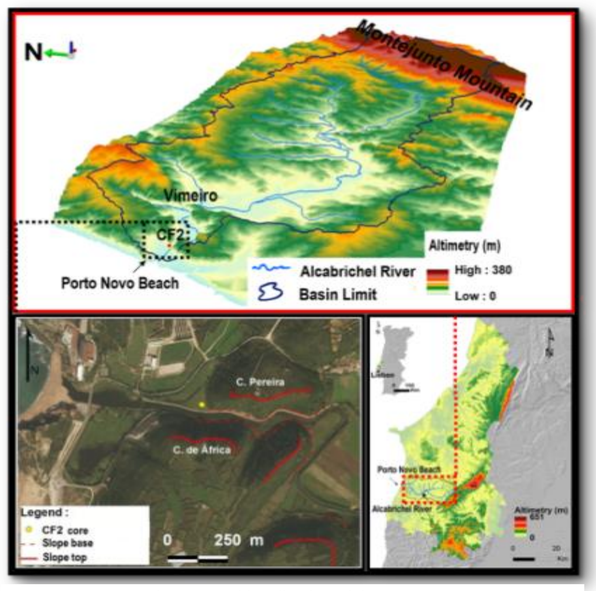
Studies on extreme marine inundations that affected the Portuguese coast refer mainly to the tsunami of AD 1775, considered the most devastating that affected the Portuguese coast.

This work is focused on the recognition of a tsunami deposit in Alcabrichel River estuary and presents the analysis of a sediment core CF2. Lithostratigraphic, sedimentological, geochemical, morphoscopic and microtextural analyses revealed a peculiar deposit, a massive layer (10cm), essentially sandy (>90%), interposed between fine sediments and the radiocarbon dating performed under the scope of R&D Project PTDC/CTE-GIX/104035/2008, placing this event in the chronological proximity of the AD 1755 Lisbon tsunami.

Key-words: tsunami deposit, geochemical indicators, morphoscopy, microtextural signatures, Alcabrichel.

STUDY AREA

The study area corresponds to the Alcabrichel River estuary (≈50km NW of Lisbon).It is a very complex tectonic context marked by the presence of two diapiric structures (Diapiro de Maceira and Diapiro de Santa Cruz). Jurassic formations dominate (57.2%) over Cretaceous and Cenozoic (29.9% and 12.9%). The area has low lithological diversity (mainly sandstones, clays and limestones) and a great geomorphological diversity with a large alluvial plain about 1 km upstream the gorge of Porto Novo (Cabeços de Africa and Pereira).



Study area and localization of the CF2 core.

MATERIALS AND METHODS

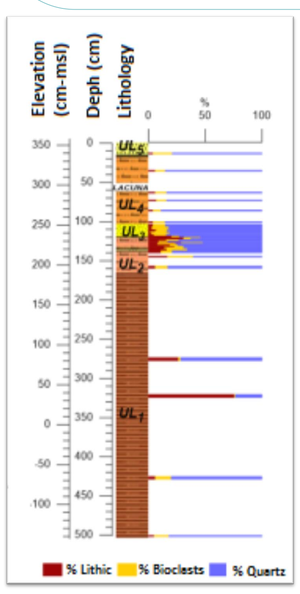
Sedimentological analyses include:

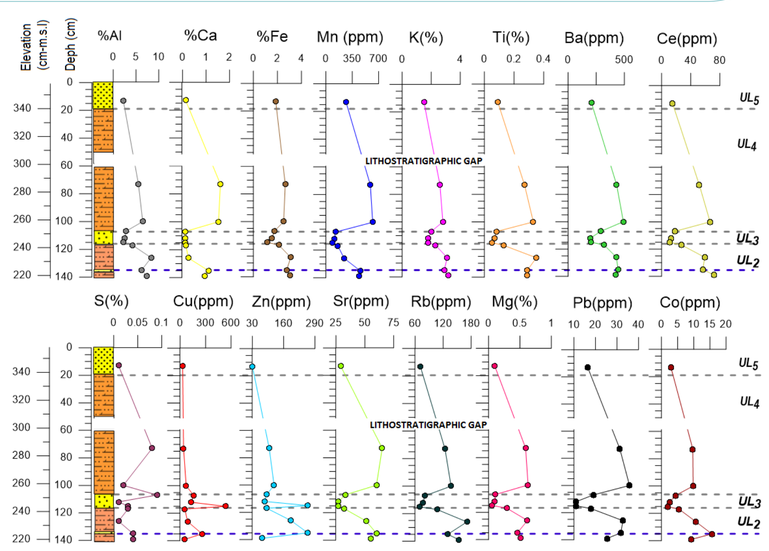
i) grain-size (sieving and laser granulometry);
ii) % $CaCO_3$ (using Eijkelkamp calcimeter);
iii) organic matter content using Loss of Ignition;
iv) geochemical analyses (performed on Activation Laboratories - Canada) - 55 chemical elements were analyzed using ICP-OES & ICP-MS;
v) morphoscopic study (analysis of 3264 sedimentary particle under a binocular loupe and separated in quartz, lithic material and bioclasts and characterization of quartz grains in terms of roundness, sphericity and superficial appearance);
vi) exoscopic study including the microtextural identification features on 259 quartz grains using high resolution images obtained with Scanning Electron Microscope (SEM) and microtextural classification based on Mahaney (2002) and Costa et al. (2012).

Results were supported by statistical methods (PCA and Cluster Analysis), using Statistica 10 software..

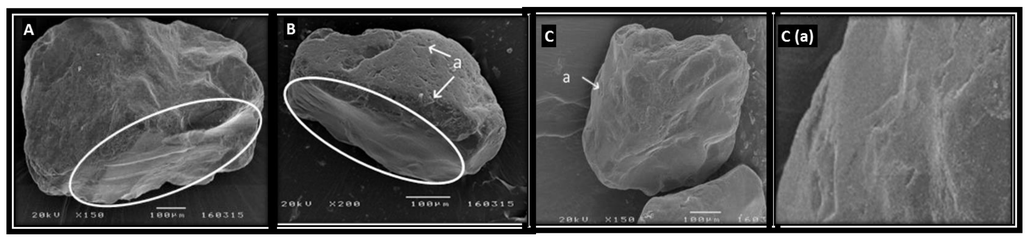
RESULTS

i. Lithostratigraphic and textural study - 5 lithostratigraphic units consist mainly of fine sediments, with an intercalated massive sandy layer (90%) - UL3 unit;
ii. Distinct geochemical signature of the UL3 unit with low % of metal elements and Al, Mn, Fe, Rb, K, and Ti; low % of Ca and sulfur (S) increase;
iii. The morphoscopic results show various depositional environments and differences in deposition energy, providing grounds for the recognition of 3 subunits in UL3.
iv. Microtextural analysis revealed low values of angularity and the abundance of fresh surfaces and percussion marks in UL3 unit.





Vertical variation of several chemical elements in CF2 core.



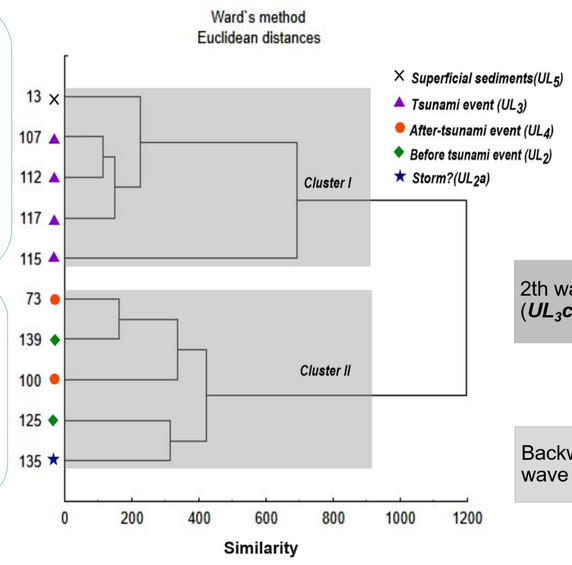
Examples of mechanical marks:
A & B fresh surfaces (white ellipses); B-a & C-a: percussion marks; C(a)-detailed view of "V" marks.

DISCUSSION

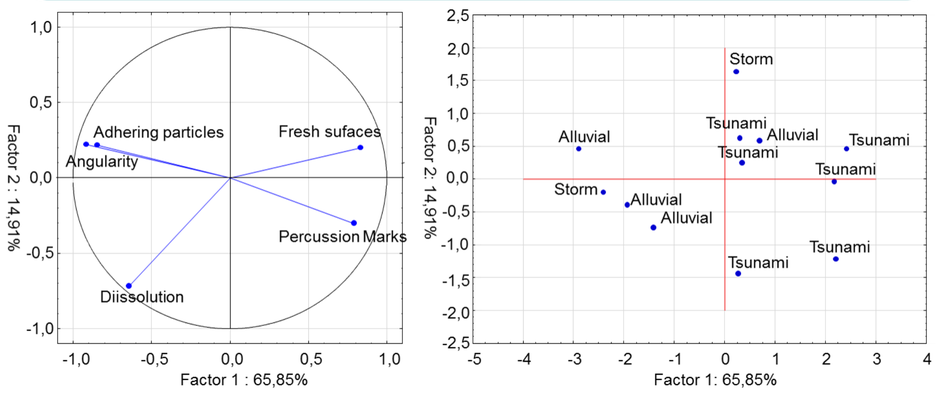
i. Lithostratigraphic and textural characterization showed that the UL3 unit is a tsunami deposit with a set of characteristics such as an abrupt basal contact and a sudden increase of the mean grain size, also detected in others tsunami deposits (Costa et al., 2010, 2012), suggesting a high-energy event.
Age-estimation calculations (257 ± 125 cal BP) allowed to associate the deposits observed in Alcabrichel river with the AD 1755 Lisbon tsunami (Ramos-Pereira et al., 2013).

ii. Geochemical analyses confirms the marine origin of the UL3 unit with low % of the elements considered as terrigenous indicators related with fine sediments and increase of the sulfur (S) considered an indicator of salt water intrusion (Chagué-Goff, 2010).
- Cluster analysis: 2 main clusters

iv. Exoscopic results show a high energetic event with abundance of mechanical marks in UL3 unit, suggesting strong hydrodynamic processes before deposition (e.g. Costa et al., 2012).
- ACP-opposition between mechanical marks and chemical marks



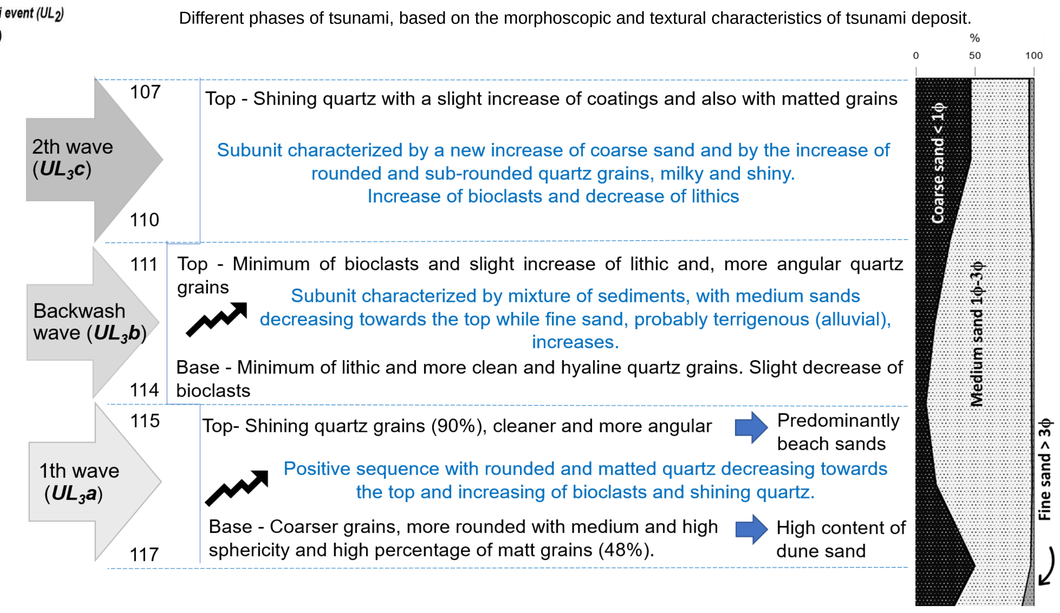
Cluster analysis of geochemical data.



Principal Component Analysis: Left- roundness and microtextural features; Right- different sedimentary environments

iii. Morphoscopic analysis was able to distinguish 3 different phases of the tsunami related to the inundation and backwash waves (Tudor, 2017).

Different phases of tsunami, based on the morphoscopic and textural characteristics of tsunami deposit.



CONCLUSION

This work demonstrated that the combination of lithostratigraphic, sedimentological, geochemical, morphoscopic and microtextural criteria provide not only the identification of the tsunami deposit, but also the reconstruction of different phases of tsunami deposition, showing the potential of these techniques in paleotsunamis studies.

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